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YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
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Systems Safety Analysis for Fire Events Associated with the ECRB Cross Drift

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10. REMARKS

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
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CONTENTS

FIGURES

Page

TABLES

Page

WARNING

ALTHOUGH EVERY EFFORT HAS GENERALLY BEEN MADE TO INCORPORATE SAFETY FEATURES INTO DESIGN, IT IS OFTEN NECESSARY TO RELY ON PROCEDURES AND TRAINING TO MITIGATE SITUATIONS THAT CAN PRODUCE HAZARDS. SAFETY IS, THEREFORE, HEAVILY DEPENDENT ON ADEQUATE TRAINING AND PROCEDURES. INADEQUATE TRAINING OR PROCEDURES OR FAILURE TO STRICTLY ADHERE TO TRAINING AND PROCEDURES CAN LEAD TO SEVERE INJURIES OR DEATH.

ACRONYMS

BSC	Bechtel SAIC Company, LLC
CIRS	Condition/Issue Identification and Reporting/Resolution System
CMO	Construction Management Organization Defense
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
ECRB	Enhanced Characterization of the Repository Block
EIS	Environmental Impact Statement
ESF	Exploratory Studies Facility
JSA	Job Safety Analysis
NRC	U.S. Nuclear Regulatory Commission
OCRWM	Office of Civilian Radioactive Waste Management
SSA	System Safety Analysis
SSC	Structure, System, or Component
TS	Topopah Springs
USGS	U.S. Geological Survey
YMP	Yucca Mountain Site Characterization Project

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1. PURPOSE

The purpose of this analysis is to systematically identify and evaluate fire hazards related to the Yucca Mountain Site Characterization Project (YMP) Enhanced Characterization of the Repository Block (ECRB) East-West Cross Drift (commonly referred to as the ECRB Cross-Drift). This analysis builds upon prior Exploratory Studies Facility (ESF) System Safety Analyses and incorporates Topopah Springs (TS) Main Drift fire scenarios and ECRB Cross-Drift fire scenarios. Accident scenarios involving the fires in the Main Drift and the ECRB Cross-Drift were previously evaluated in *Topopah Springs Main Drift System Safety Analysis* (CRWMS M&O 1995) and the *Yucca Mountain Site Characterization Project East-West Drift System Safety Analysis* (CRWMS M&O 1998). In addition to listing required mitigation/control features, this analysis identifies the potential need for procedures and training as part of defense-in-depth mitigation/control features. The inclusion of this information in the System Safety Analysis (SSA) is intended to assist the organization(s) (e.g., Construction, Environmental Safety and Health, Design) responsible for these aspects of the ECRB Cross-Drift in developing mitigation/control features for fire events, including Emergency Refuge Station(s). This SSA was prepared, in part, in response to Condition/Issue Identification and Reporting/Resolution System (CIRS) item 1966.

The SSA is an integral part of the systems engineering process, whereby safety is considered during planning, design, testing, and construction. A largely qualitative approach is used which incorporates operating experiences and recommendations from vendors, the constructor and the operating contractor. The risk assessment in this analysis characterizes the scenarios associated with fires in terms of relative risk and includes recommendations for mitigating all identified hazards. The priority for recommending and implementing mitigation control features is:

- Incorporate measures to reduce risks and hazards into Structure, System, or Component (SSC) designs
- Add safety features and capabilities to existing designs
- Develop procedures and conduct training to increase worker awareness of potential hazards, reduce exposure to hazards, and inform personnel of the actions required to avoid accidents or correct hazardous conditions.

2. QUALITY ASSURANCE

This SSA was prepared in accordance with YAP-30.48, *System Safety Analysis*, and other procedures invoked by YAP-30.48. This work scope is identified in the *Technical Work Plan For: Preclosure Safety Analysis* (BSC 2001b).

3. METHOD

The safety/risk assessment methodology used in this analysis is documented in procedure YAP-30.48, *System Safety Analysis*. The result of the analysis is a "risk evaluation" of the scenarios or hazards identified in this analysis in accordance with *Military System Safety Program Requirements* (DOD 1993). Three steps are required to complete the risk evaluation:

(1) hazard/scenario identification, (2) frequency assessment, and (3) consequence assessment. The word "accident" as used in this analysis refers to events, breakdowns, incidents, or any other occurrence that may have a negative effect on personnel safety.

3.1 HAZARD SCENARIO IDENTIFICATION

The first step of the risk assessment process involves the identification of possible accident scenarios that can have negative consequences for the ESF personnel or facilities. It is important to provide assurance that potentially significant scenarios have been considered and the consequences are appropriately mitigated through design selection, safety design features or devices, detection and warning devices, and/or use of procedures and training.

3.2 FREQUENCY ASSESSMENT

In general, bounding frequency estimates are developed for the accident scenarios and system failures. The frequency rating scale documented in YAP-30.48 contains five levels of estimated frequency. The frequency levels are shown in Table 1.

Table 1. Frequency Rating Scale

Frequency		Description
A	Frequent	Likely to occur frequently
B	Probable	Will occur several times in the life of an SSC
C	Occasional	Likely to occur some time in the life of an SSC
D	Remote	Unlikely but possible to occur in the life of an SSC
E	Improbable	So unlikely, it can be assumed occurrence may not be experienced

3.3 CONSEQUENCE ASSESSMENT

The potential range of consequences, from minor health effects to injury and/or fatality, is determined by using a consequence rating scale, which is also documented in YAP-30.48. The rating scale and definitions are presented in Table 2. The consequence rating scale also addresses potential impacts to site characterization data ranging from no loss of data to an irretrievable loss of license application data. The determination of consequence for each

scenario, like the frequency estimate, was based on engineering experience and judgment and historical operating data.

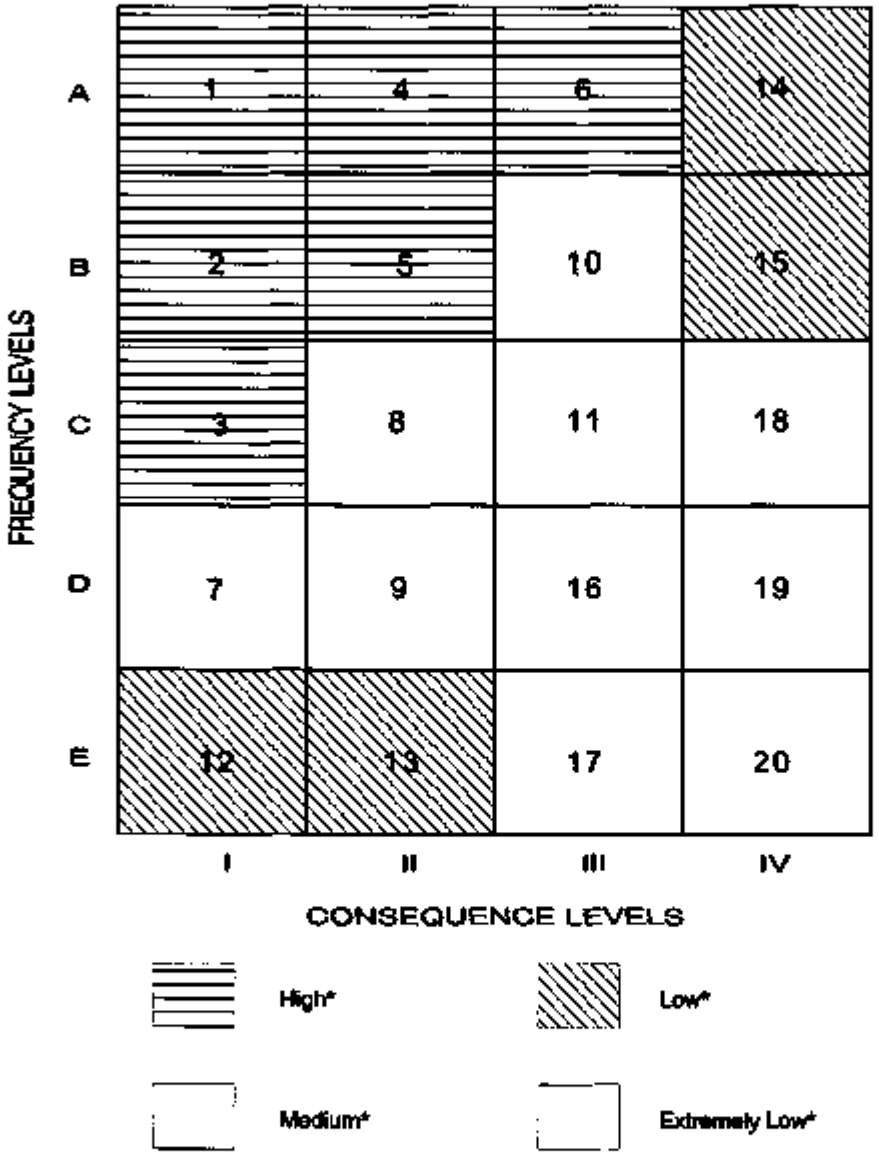
Table 2. Consequence Rating and Definition

Consequence Level		Maximum Consequence
I	Catastrophic	Death, system/equipment loss, or severe environmental impact
II	Critical	Severe injury or illness, major system/equipment or environmental damage
III	Marginal	Minor injury or illness, minor system/equipment damage, minor delay of data collection or loss of data
IV	Negligible	Less than minor injury, occupational illness, or system damage

3.4 RISK ASSESSMENT

Risk is a function of frequency and consequence. The level of risk is determined by assigning a qualitative rating (high, medium, low, extremely low) to each of the frequency and consequence combinations. By determining the frequency of occurrence and level of consequence for each scenario, the risk classification for each scenario is determined by using the risk matrix in Figure 1. Within each risk category there is a precedence, based on consequence and frequency. For example, a scenario with a frequency of Frequent and a consequence level of Catastrophic has a higher risk than a scenario with a frequency of Frequent and a consequence level of Critical.

Figure 1 Risk Matrix



*** DOE is responsible for defining the criteria for risk acceptability**

Since the levels of risk are largely subjective, the risk designations must be viewed as relative. Relative risks are useful for determining the order in which risks are addressed; they are not absolute measures. Absolute risk is used when sufficient historical operating data is available on the same design as is currently being utilized and under the same operating conditions.

Nonetheless, relative risk can be used as a management tool, especially when mitigation features have not been established and/or verified.

4. CODES, STANDARDS, AND REFERENCES

4.1 DOCUMENTS CITED

BSC (Bechtel SAIC Company) 2001a. *Calculation of ECRB Cross-Drift Worst-Case Fire and Effects*. BAB000000-01717-0210-00001 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20011206.0227.

BSC 2001b. *Technical Work Plan For: Preclosure Safety Analysis*. TWP-MGR-SE-000010 REV01. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20011105.0325.

BSC 2001c. *Exploratory Studies Facility Fire Hazards Analysis*. BABFAH000-01717-0210-00121 REV 02. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010917.0184.

BSC 2001d. *ECRB Refuge Chamber*. BABEAF000-01717-0210-00011 REV 00. Las Vegas, Nevada: Bechtel SAIC Company.

BSC 2001e. *Determination, Decision, or Directive Documentation*. DF: 02-0013. Las Vegas, Nevada: Bechtel SAIC Company.

BSC 2001f. *ECRB Refuge Station General Arrangement and Details*. BABEAF000-01717-2100-40361 REV 00 DCN01. Las Vegas, Nevada: Bechtel SAIC Company.

CRWMS M&O 1995. *Topopah Springs Main Drift System Safety Analysis*. BAB000000-01717-0200-00149, REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19960606.0010.

CRWMS M&O 1998. *Yucca Mountain Site Characterization Project East-West Drift System Safety Analysis*. BAB000000-01717-0200-00004, REV 01 . Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980825.0270.

Kubicek, J.L. 2001. *Exploratory Studies Facility Subsurface Fire Hazards Analysis*. BABFAH000-01717-0200-00121 REV 02. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010917.0184.

4.2 CODES, STANDARDS, AND REGULATIONS

ANSI/IEEE (American National Standards Institute/Institute of Electrical and Electronics Engineers) Standard C2, "National Electrical Safety Code".

DOD (U.S. Department of Defense) 1993. *Military System Safety Program Requirements*. MILSTD882C. U.S. Department of Defense, Washington, D.C. TIC: 209468.

NFPA (National Fire Protection Association) 122, "Standard for Fire Prevention and Control in Underground Metal and Nonmetal Fires".

NFPA 30, "Flammable and Combustible Liquids Code".

OSHA (Occupational Safety and Health Administration, Department of Labor) - 29 CFR 1926 Subpart S; "Underground Construction, Caissons, Cofferdams and Compressed Air".

YAP-30.48 Rev 1, ICN 2, "System Safety Analysis".

5. ASSUMPTIONS

- BSC will verify that the mitigation features required in this SSA are effectively implemented and are properly documented.

- The conclusions of this SSA pertain only to the scenarios identified herein; specifically, they pertain to scenarios UI6001 to UI6005, as Listed in Table 3 and described in Appendix A. The Scenario descriptions provided in Appendix B are provided for information only. The hazard and risk information for these scenarios may not be current or complete and may be too severe when evaluated in light of current operations in the ECRB.

- Future design changes will need to be evaluated to determine the impact on personnel safety and health. As future operational changes occur, this document and the scenarios provided (in Appendix A and Appendix B) will be re-examined and re-evaluated for the applicability of the scenarios to proposed operations and the applicability of mitigation/control features to these scenarios; especially as they apply to the ECRB.

- All procedures, training, manuals, and other documentation identified as mitigation features are complete, comprehensive, and accurate.

6. RESULTS

The six SSA Accident Analysis Summaries involving fires in the ECRB Cross Drift, based on the *Exploratory Studies Facility Subsurface Fire Hazards Analysis* (Kubicek 2001) as well as the previously analyzed fire scenarios (presented in Table 4 and Appendix B), are presented in Appendix A. The previously analyzed SSA Accident Analysis Summaries involving fires in the ECRB Cross Drift as well as the TS Main Drift are reproduced in Appendix B. It should be noted that the scenarios in Appendix B are included for information purposes only, as described in Section 5. Due to the similarities of the designed systems in the TS Main Drift and the ECRB Cross-Drift, the TS Main Drift scenarios were used as a basis for developing the ECRB Cross-Drift scenarios in Appendix B. The analysis of the six scenarios in Appendix A focused on personnel safety and health hazards associated with fires in the ECRB Cross-Drift for the purposes of qualitatively assigning a Hazard Classification to each scenario. The final Hazard Classification is based on the mitigation/control features required to achieve the final frequency and consequence levels. These six scenarios include the use of the ECRB Alcove 8 refuge station (equipped with bottled air) and the Station 73+63 Refuge Station as part of the mitigation/control features required to protect workers from the consequences of a fire in the ECRB Cross Drift.

The List of Scenarios Evaluated (Table 3) and List of Scenarios Previously Evaluated (Table 4) both contain a brief description of each scenario and a final frequency, consequence and risk rating that assumes that all of the mitigations and controls recommended have been fully implemented. A total of eighteen (18) scenarios are listed in these two tables. The detailed scenario analysis summaries are contained in Appendices A and B. Again, it should be noted that the scenarios in Appendix B are included for informational purposes only. The hazard risk information may not be applicable to the current physical characteristics and hazards associated with the ECRB and/or the Main Drift. In addition, mitigation and control features to address those hazards included in Appendix B may not be applicable to the current ECRB design and current ECRB operations.

Each scenario was assigned a final risk level based upon the frequency and consequence of the potential hazards identified. In this analysis, there were zero (0) scenarios with a ***high*** risk designation, zero (0) scenarios with a ***medium*** risk designation, eleven (11) scenarios with a ***low*** risk designation, and six (7) scenarios with an ***extremely low*** risk designation. The Hazard Risk Matrix (Figure 2) illustrates the distribution of the risk ratings of the scenarios within the matrix.

The risk designation serves two purposes:

1) It is a qualitative indicator that can be used by management to determine whether the level of risk is acceptable or if additional safety mitigation features must be implemented to lower the risk to an acceptable level.

2) It is a management tool that can be used to determine the order for addressing hazards and implementing the associated mitigation features.

All of the events evaluated in this SSA were assigned a Final Hazard Classification of Low to Extremely Low. The worst-case fire, Scenario UI6005, has an Initial Hazard Classification of Medium due to a Remote Frequency Level and a Catastrophic Consequence Level. The Final Hazard Classification Level of this scenario (taking into account the required mitigation/control features) is Low based on a Catastrophic Final Consequence Level and an Improbable Frequency Level The Catastrophic Final Consequence Level (indicating that death and/or severe system/equipment damage may occur) reflects the conclusion that, in the event of the worst-case fire, personnel would only have between 50 and 60 seconds to seek refuge, as reported in *Calculation of ECRB Cross-Drift Worst-Case Fire and Effects* (BSC 2001a). For this reason, the Catastrophic Final Consequence Level is required for this scenario. Mitigation/control features such as automatic fire suppression equipment on the refueling/maintenance railcar, muck conveyors, locomotives, and diesel-powered equipment serve to reduce the frequency of a fire of such a severe magnitude that loss of life or severe system/equipment damage could occur, resulting in a Final Frequency Level of Improbable. Based on these frequency and consequence levels, a Final Hazard Classification of Low is assigned to the scenario.

7. CONCLUSIONS

The *Exploratory Studies Facility Subsurface Fire Hazards Analysis* (Kubicek 2001), SSAs previously completed concerning fire hazards, and the *Calculation of ECRB Cross-Drift Worst-Case Fire and Effects* (BSC 2001a) analyses were examined to evaluate the ECRB fire-related

hazards, identify mitigation measures to control the hazards by design and/or administrative controls (including the use of an emergency refuge stations), and perform an assessment of the risk. The six SSA Accident Analysis Summaries based on this analysis are presented in Appendix A. All of the events evaluated in this SSA were assigned a Final Hazard Classification of Low to Extremely Low. Information concerning the design and hazards associated with the ECRB Cross-Drift was obtained from the M&O ESF Design organization (BSC 2001d, BSC2001e).

Table 3 List of Scenarios Evaluated

Scenario ID Number	Risk Level	Frequency	Consequence	Scenario Description
UI6001	Low	E - Improbable	II - Critical	Locomotive fire in the engine compartment, igniting diesel fuel Potential diesel spill could release up to a full tank (189 3 liters [50 gallons]) of fuel The burning diesel fuel damages the locomotive and equipment in the area, this damage could be severe with system/equipment loss, and workers in the area could potentially be injured
UI6002	Low	E - Improbable	II - Critical	Fire resulting from an accident with the maintenance railcar (either during transportation in the drift or when transporting combustible liquids [such as fuel] from the onboard storage tanks to mobile equipment) Equipment in the immediate area is damaged, with the potential for system/equipment loss or damage Workers in the area could potentially be injured by the fire
UI6003	Extremely Low	E - Improbable	III - Marginal	Diesel-powered mobile equipment onboard fire The equipment is damaged with potential for major system/equipment damage and potential injury to workers
UI6004	Extremely Low	E - Improbable	III - Marginal	Fire inside power distribution equipment, fire due to failure of electrical switchgear or other electrical equipment The damage to equipment/systems is minor with minor potential injury to workers
UI6005	Low	E - Improbable	I - Catastrophic	A vehicle fuel tank or maintenance railcar storage tank ruptures, leaking diesel fuel from tank is ignited in the ECRB Cross-Drift The initial fire consumes the available diesel fuel and other fuel tanks fail in a successive manner Fire spreads to consume the ECRB Cross-Drift conveyor belt, and then consumes ECRB Cross-Drift wood rail ties The potential exists for severe system/equipment damage and the potential exists for loss of life to workers as a result of this fire
UI6006	Extremely Low	D - Remote	IV - Negligible	Fire due to the ignition of trash, solvents, chemicals, or other combustible products Minor system/equipment damage results from this fire with the potential for minor injury to workers

Table 4. List of Scenarios Previously Evaluated

Scenario ID Number	Scenario Location	Risk Level	Frequency	Consequence	Scenario Description
UI5028	East-West Drift	Extremely Low	E - Improbable	III - Marginal	Fire involving subsurface vehicle (e.g., Alpine Miner, front-end loader, drill jumbo) or temporarily stored materials.
UI5030	East-West Drift	Extremely Low	D - Remote	III - Marginal	Fire due to failure/short/overload of electrical switchgear or other electrical equipment (e g , transformer, electrical panel box, electrical wire or cable).
UI5057	East-West Drift	Extremely Low	D - Remote	III - Marginal	General underground fire due to ignition of trash, solvents, chemicals, or other combustible products
UI5080	East-West Drift	Low	E - Improbable	II - Critical	Fire hazards: Conveyor system.
UI5086	East-West Drift	Low	E - Improbable	II - Critical	Vehicle diesel fire hazard diesel leak(s) from fuel tank or fuel lines during refueling activities (dropping container, inattention to refueling process)
UI0354	Main Drift	Extremely Low	D - Remote	III - Marginal	Personnel injury/equipment damage caused by a diesel fuel fire due to diesel fuel leak within engine compartment
UI0355	Main Drift	Low	E - Improbable	II - Critical	Personnel injury/equipment damage caused by a diesel fuel fire due to electrical ignition sources in the presence of diesel fuel, hydraulic fluid, lubricating oil, flammable cleaning solvents, disposable clean-up materials.
UI0356	Main Drift	Low	E - Improbable	II - Critical	Personnel injury/equipment damage caused by a diesel fuel fire due to mechanical ignition sources in the presence of diesel fuel, hydraulic fluid, lubricating oil, flammable cleaning solvents, disposable clean-up materials
UI0357	Main Drift	Low	E - Improbable	II - Critical	Personnel injury/equipment damage caused by a diesel fuel fire due to ignition by open flame or heating device in the presence of diesel fuel, hydraulic fluid, lubricating oil, flammable cleaning solvents, disposable clean up materials
UI0358	Main Drift	Low	E - Improbable	II - Critical	Personnel injury/equipment damage caused by diesel fire on diesel locomotive while transporting diesel fuel into tunnel
UI0359	Main Drift	Low	E - Improbable	II - Critical	Personnel injury/equipment damage caused by fire in diesel fuel storage area.
UI0361	Main Drift	Low	E - Improbable	II - Critical	Personnel injury/equipment damage caused by a diesel fuel fire due to diesel fuel leak from fuel tank.

Figure 2. Scenarios Distributed Over Hazard Risk Matrix

FREQUENCY LEVELS	I	II	III	IV
A	**High**	**High**	**High**	**Low**
B	**High**	**Medium**	**Medium**	**Low**
C	**High**	**Medium**	**Medium**	**Extremely Low**
D	**Medium**	**Medium**	**Extremely Low** UI5030 UI5057 UI0354	**Extremely Low** UI6006
E	**Low** UI6005	**Low** UI5080 UI5086 UI0355 UI0356 UI0357 UI0358 UI0359 UI0361 UI6001 UI6002	**Extremely Low** UI5028 UI6003 UI6004	**Extremely Low** UI5081

CONSEQUENCE LEVELS

Frequency Levels
A - Frequent
B - Probable
C - Occasional
D - Remote
E - Improbable

Consequence Levels
I - Catastrophic
II - Critical
III - Marginal
IV - Negligible

APPENDIX A

SCENARIO ANALYSIS SUMMARIES

Scenario Analysis Summary

1. **Scenario Number:** U1600J	2. **Revision:** 0	3. **Revision Date:** December 2001

4. **Location:** ECRB Cross-Drift

5. **Scenario Description:** Locomotive fire in the engine compartment, igniting diesel fuel. Potential diesel spill could release up to a full tank (189.3 liters [50 gallons]) of fuel. The burning diesel fuel damages the locomotive and equipment in the area, this damage could be severe with system/equipment loss, and workers in the area could potentially be injured.

6. **Cause, Failure, or Hazardous Event:**
   - Diesel fuel spill or leak onto hot surfaces (e.g. brakes, worn bearings)
   - Diesel fuel line leak caused by age, rust, or wear
   - Diesel fuel leak due to failure of mechanical joint
   - Diesel fuel leak during refueling of diesel equipment
   - Human Error
   - Failure to adhere to safety procedures and rules
   - Component failure (e.g., valve leak)

7. **INITIAL Hazard Classification:**

Frequency Rating	E - Improbable
Consequence Rating	I - Catastrophic
Initial Risk Rating	Low

8. a. **Required Mitigation/Control Features:** (Implementation and Verification Required)
   - Emergency Refuge Stations in the ECRB Cross-Drift: 1) Alcove 8 refuge station equipped with respirators/bottle air system, half-mask respirators, and self-contained self-rescuers, 2) Bulkhead 17+63 refuge station with large volume of drift air equipped with gas detection/monitoring equipment and half-mask respirators
   - Procedures/controls to limit the number of visitors/workers in the ECRB Cross-Drift according to the number of respirators/compressed air bottles in the Emergency Refuge Station at Alcove 8 (30 persons corresponding to 30 bottles, up to a maximum of 53 persons corresponding to 53 bottles)
   - Automatic fire suppression on the locomotive
   - Fire suppression system/equipment (e.g. portable multi-purpose dry chemical fire extinguishers)
   - Personal self-rescuers
   - Install ESF alarm/notification system improvements
   - Install exit and emergency lighting systems

   b. **Defense-in-Depth Mitigation/Control Features:** (Implementation not required by the SSA to reach the Final Risk Rating. NOTE: May be required to satisfy other regulatory requirements (i.e., OSHA)
   - Compressed air system as redundant air supply system to the ECRB Cross-Drift Emergency Refuge Station(s)
   - Fire emergency procedures
   - Establish regular inspection and maintenance procedures and schedule, maintain inspection and safety records
   - Safety training

9. Mitigation Documentation:

- Exploratory Studies Facility Subsurface Fire Hazards Analysis, BABFAH000-01717-0200-00121 Rev 02
- Calculation of ECRB Cross-Drift Worst-Case Fire and Effects, BAB000000-01717-0210-00001 Rev 00
- ECRB Refuge Station General Arrangement and Details BABEAF000-01717-2100-40361 REV 00 DCN01
- ECRB Refuge Chamber, BABEAF000-01717-0210-00011 REV00
- Determination, Decision, or Directive Documentation DF 02-0013
- NFPA 122, Standard for Fire Prevention and Control in Underground Metal and Nonmetal Fires
- OSHA - 29 CFR 1926 Subpart S, Underground Construction, Caissons, Cofferdams, and Compressed Air
- NFPA 30, Flammable and Combustible Liquids Code
- Emergency evacuation plan and procedures
- General Safety Manuals and Training
- Operating and Maintenance Instructions

Note: Upon completion of the installation of the Emergency Refuge Stations, the drawings, training lesson plans, procedures, manufacturer's operations and maintenance manuals, etc. will be updated to reflect the design and operation of the Emergency Refuge Stations as well as other mitigation/control features.

10. FINAL Hazard Classification:

Frequency Rating	E - Improbable
Consequence Rating	II - Critical
Initial Risk Rating	Low

Scenario Analysis Summary		
1. Scenario Number: U[6002	**2. Revision:** 0	**3. Revision Date:** December 2001
4. Location: ECRB Cross-Drift		

5. Scenario Description: Fire resulting from an accident with the maintenance railcar (either during transportation in the drift or when transporting combustible liquids [such as fuel] from the onboard storage tanks to mobile equipment). Equipment in the immediate area is damaged; with the potential for system/equipment loss or damage. Workers in the area could potentially be injured by the fire.

6. Cause, Failure, or Hazardous Event:

- Mechanical failure(s) of container/tank
- Failure of fuel lines/joints
- Human error during refueling activities (dropping container, inattention to refueling process)
- Diesel fuel spill or leak onto hot surfaces (e.g., brakes, worn bearings)
- Failure to adhere to safety procedures and rules
- Component failure (e.g., valve leak)

7. <u>INITIAL</u> Hazard Classification:

Frequency Rating:	E - Improbable
Consequence Rating:	1 - Catastrophic
Initial Risk Rating:	Low

8. a. Required Mitigation/Control Features: (Implementation and Verification Required)

- Emergency Refuge Stations in the ECRB Cross-Drift 1) Alcove 8 refuge station equipped with respirators/bottle air system, half-mask respirators, and self-contained self-rescuers, 2) Bulkhead 17+63 refuge station with large volume of drift air equipped with gas detection/monitoring equipment and half-mask respirators
- Procedures/controls to limit the number of visitors/workers in the ECRB Cross-Drift according to the number of respirators/compressed air bottles in the Emergency Refuge Station at Alcove 8 (30 persons corresponding to 30 bottles, up to a maximum of 53 persons corresponding to 53 bottles)
- Procedures/controls to limit the number of workers in the ECRB Cross-Drift to 5 (five) when the maintenance cart is pulled into the ECRB Cross-Drift to perform refueling activities
- Fire suppression system/equipment (e g , portable multi-purpose dry chemical fire extinguishers)
- Personal Self-Rescuers
- Automatic fire suppression on the refueling vehicle/maintenance railcar
- Establish procedures for refueling activities, including establishing the number of workers required for refueling activities

b. Defense-in-Depth Mitigation/Control Features: Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)

- Compressed air system as redundant air supply system to the ECRB Cross-Drift Emergency Refuge Station(s)
- Fire emergency procedures
- Establish regular inspection and maintenance procedures and schedule, including diesel engine compartment and fuel lines, maintain inspection and safety records
- Operator training on proper methods for handling diesel fuel and refueling procedures
- Safety training

9. Mitigation Documentation:

- Exploratory Studies Facility Subsurface Fire Hazards Analysis, BABFAH000-01717-0200-00121 Rev 02
- Calculation of ECRB Cross-Drift Worst-Case Fire and Effects, BAB000000-01717-0210-00001 Rev 00
- ECRB Refuge Chamber, BABEAF000-01717-0210-00011 REV00
- ECRB Refuge Station General Arrangement and Details BABEAF000-01717-2100-40361 REV 00 DCN01
- Determination, Decision, or Directive Documentation DF 02-0013
- NFPA 122, Standard for Fire Prevention and Control in Underground Metal and Nonmetal Fires
- OSHA - 29 CFR 1926 Subpart S, Underground Construction, Caissons, Cofferdams, and Compressed Air
- Emergency evacuation plan and procedures
- General Safety Manuals and Training
- Operating and Maintenance Instructions

Note: Upon completion of the installation of the Emergency Refuge Stations, the drawings, training lesson plans, procedures, manufacturer's operations and maintenance manuals, etc. will be updated to reflect the design and operation of the Emergency Refuge Stations as well as other mitigation/control features.

10. FINAL Hazard Classification:

Frequency Rating	E - Improbable
Consequence Rating	II - Critical
Initial Risk Rating	Low

Scenario Analysis Summary		
1. Scenario Number: UI6003	**2. Revision:** 0	**3. Revision Date:** December 2001
4. Location: ECRB Cross-Drift		
5. Scenario Description: Diesel-powered mobile equipment onboard fire. The equipment is damaged with potential for major system/equipment damage and potential injury to workers		
6. Cause, Failure, or Hazardous Event: • Accident involving transient combustible materials • Unsafe vehicles (e g., improper maintenance) • Diesel fuel spill or leak onto hot surfaces (e g., brakes, worn bearings) • Diesel fuel line leak caused by age, rust, or wear • Diesel fuel leak due to failure of mechanical joint • Diesel fuel leak during refueling of diesel equipment • Human error • Failure to adhere to safety procedures and rules • Component failure		
7. <u>INITIAL</u> Hazard Classification: Frequency Rating: E - Improbable Consequence Rating: II - Critical Initial Risk Rating: Low		

8. a. **Required Mitigation/Control Features:** (Implementation and Verification Required)

- Emergency Refuge Stations in the ECRB Cross-Drift 1) Alcove 8 refuge station equipped with respirators/bottle air system, half-mask respirators, and self-contained self-rescuers, 2) Bulkhead 17+63 refuge station with large volume of drift air equipped with gas detection/monitoring equipment and half-mask respirators
- Procedures/controls to limit the number of visitors/workers in the ECRB Cross-Drift according to the number of respirators/compressed air bottles in the Emergency Refuge Station at Alcove 8 (30 persons corresponding to 30 bottles, up to a maximum of 53 persons corresponding to 53 bottles)
- Procedures/controls to limit the number of workers in the ECRB Cross-Drift to 5 (five) when the maintenance cart is pulled into the ECRB Cross-Drift to perform refueling activities
- Automatic fire suppression on diesel-powered mobile equipment
- Fire suppression system/equipment (e g , portable multi-purpose dry chemical fire extinguishers)
- Install ESF alarm/notification system improvements
- Personal self-rescuers

b. **Defense-in-Depth Mitigation/Control Features:** Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)

- Compressed air system as redundant air supply system to the ECRB Cross-Drift Emergency Refuge Station(s)
- Fire emergency procedures
- Establish regular inspection and maintenance procedures and schedule, maintain inspection and safety records
- Safety training

9. **Mitigation Documentation:**

- Exploratory Studies Facility Subsurface Fire Hazards Analysis, BABFAH000-01717-0200-00121 Rev 02
- Calculation of ECRB Cross-Drift Worst-Case Fire and Effects, BAB000000-01717-0210-00001 Rev 00
- ECRB Refuge Chamber, BABEAF000-01717-0210-00011 REV00
- ECRB Refuge Station General Arrangement and Details BABEAF000-01717-2100-40361 REV 00 DCN01
- Determination, Decision, or Directive Documentation DF 02-0013
- NFPA 122, Standard for Fire Prevention and Control in Underground Metal and Nonmetal Fires
- OSHA - 29 CFR 1926 Subpart S, Underground Construction, Caissons, Cofferdams, and Compressed Air
- NFPA 30, Flammable and Combustible Liquids Code
- Emergency evacuation plan and procedures
- General Safety Manuals and Training
- Operating and Maintenance Instructions

Note: Upon completion of the installation of the Emergency Refuge Stations, the drawings, training lesson plans, procedures, manufacturer's operations and maintenance manuals, etc. will be updated to reflect the design and operation of the Emergency Refuge Stations as well as other mitigation/control features.

10. **FINAL Hazard Classification:**

Frequency Rating E - Improbable
Consequence Rating III - marginal
Initial Risk Rating Extremely Low

Scenario Analysis Summary		
1. Scenario Number: UI6004	2. Revision: 0	3. Revision Date: December 2001

4. Location: ECRB Cross-Drift

5. Scenario Description: Fire inside power distribution equipment, fire due to failure of electrical switchgear or other electrical equipment The damage to equipment/systems is minor with minor potential injury to workers

6. Cause, Failure, or Hazardous Event:

- Short circuit, wire insulation failure
- Transformer or electrical panel failure or overload
- Lighting fixture failure or damage
- Battery or generator electrical discharge
- Human error (bad wiring)
- Component failure

7. INITIAL Hazard Classification:

Frequency Rating	D - Remote
Consequence Rating	III - Marginal
Initial Risk Rating	Extremely Low

8. a. Required Mitigation/Control Features: (Implementation and Verification Required)

- Emergency Refuge Stations in the ECRB Cross-Drift 1) Alcove 8 refuge station equipped with respirators/bottle air system, half-mask respirators, and self-contained self-rescuers, 2) Bulkhead 17+63 refuge station with large volume of drift air equipped with gas detection/monitoring equipment and half-mask respirators
- Procedures/controls to limit the number of visitors/workers in the ECRB Cross-Drift according to the number of respirators/compressed air bottles in the Emergency Refuge Station at Alcove 8 (30 persons corresponding to 30 bottles, up to a maximum of 53 persons corresponding to 53 bottles)
- Fire suppression system/equipment (e g , portable multi-purpose dry chemical fire extinguishers)
- Design electrical systems to all applicable codes and standards
- Conduct inspections during installation and connection to power supply
- Use protective devices (e g , fuses, circuit breakers) where appropriate
- Field test according to applicable specifications
- Ensure cable and equipment meet applicable codes and standards
- Install ESF alarm/notification system improvements
- Personal self-rescuers

b. Defense-in-Depth Mitigation/Control Features: Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)

- Compressed air system as redundant air supply system to the ECRB Cross-Drift Emergency Refuge Station(s)
- Fire emergency procedures
- Establish regular inspection and maintenance procedures and schedule, maintain inspection and safety records
- Safety training

9. Mitigation Documentation:

- Exploratory Studies Facility Subsurface Fire Hazards Analysis, BABFAH000-01717-0200-00121 Rev. 02
- Calculation of ECRB Cross-Drift Worst-Case Fire and Effects, BAB000000-01717-0210-00001 Rev. 00
- ECRB Refuge Chamber, BABEAF000-01717-0210-00011 REV00
- ECRB Refuge Station General Arrangement and Details. BABEAF000-01717-2100-40361 REV 00 DCN01
- Determination, Decision, or Directive Documentation. DF: 02-0013
- ANSI/IEEE C2, National Electrical Safety Code
- OSHA - 29 CFR 1926 Subpart S, Underground Construction, Caissons, Cofferdams, and Compressed Air
- NEMA and UL standards
- System Specifications
- Maintenance Manuals
- Safety Manuals
- Inspection and Maintenance Records

Note: Upon completion of the installation of the Emergency Refuge Stations, the drawings, training lesson plans, procedures, manufacturer's operations and maintenance manuals, etc. will be updated to reflect the design and operation of the Emergency Refuge Stations as well as other mitigation/control features.

10. FINAL Hazard Classification:

Frequency Rating:	E - Improbable
Consequence Rating:	III - Marginal
Initial Risk Rating:	Extremely Low

Scenario Analysis Summary		
1. Scenario Number: UI6005	**2. Revision:** 0	**3. Revision Date:** December 2001
4. Location: ECRB Cross-Drift		

5. Scenario Description: A vehicle fuel tank or maintenance railcar storage tank ruptures, leaking diesel fuel from tank is ignited in the ECRB Cross-Drift The initial fire consumes the available diesel fuel and other fuel tanks fail in a successive manner Fire spreads to consume the ECRB Cross-Drift conveyor belt, and then consumes ECRB Cross-Drift wood rail ties The potential exists for severe system/equipment damage and the potential exists for loss of life to workers as a result of this fire

6. Cause, Failure, or Hazardous Event:

- Mechanical failure(s) of fuel tank(s)
- Failure of fuel lines/joints
- Diesel fuel spill or leak onto hot surfaces (e g , brakes, worn bearings)
- Component failure (e g valve leak)

7. INITIAL Hazard Classification:

Frequency Rating	D - Remote
Consequence Rating	I - Catastrophic
Initial Risk Rating	Medium

8. a. Required Mitigation/Control Features: (Implementation and Verification Required)

- Emergency Refuge Stations in the ECRB Cross-Drift 1) Alcove 8 refuge station equipped with respirators/bottle air system, half-mask respirators, and self-contained self-rescuers, 2) Bulkhead 17+63 refuge station with large volume of drift air equipped with gas detection/monitoring equipment and half-mask respirators
- Procedures/controls to limit the number of visitors/workers in the ECRB Cross-Drift according to the number of respirators/compressed air bottles in the Emergency Refuge Station at Alcove 8 (30 persons corresponding to 30 bottles, up to a maximum of 53 persons corresponding to 53 bottles)
- Procedures/controls to limit the number of workers in the ECRB Cross-Drift to 5 (five) when the maintenance cart is pulled into the ECRB Cross-Drift to perform refueling activities
- Fire suppression system/equipment (e g , portable multi-purpose dry chemical fire extinguishers)
- Automatic fire suppression on the refueling vehicle/maintenance railcar, muck conveyors, locomotives, and diesel-powered mobile equipment
- Install ESF alarm/notification system improvements
- Personal self-rescuers

b. Defense-in-Depth Mitigation/Control Features: Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)

- Compressed air system as redundant air supply system to the ECRB Cross-Drift Emergency Refuge Station(s)
- Fire emergency procedures
- Establish regular inspection and maintenance procedures and schedule, maintain inspection and safety records
- Safety training

9. Mitigation Documentation:

- Exploratory Studies Facility Subsurface Fire Hazards Analysis, BABFAH000-01717-0200-00121 Rev. 02
- Calculation of ECRB Cross-Drift Worst-Case Fire and Effects, BAB000000-01717-0210-00001 Rev. 00
- ECRB Refuge Chamber, BABEAF000-01717-0210-00011 REV00
- ECRB Refuge Station General Arrangement and Details. BABEAF000-01717-2100-40361 REV 00 DCN01
- Determination, Decision, or Directive Documentation. DF: 02-0013
- NFPA 122, Standard for Fire Prevention and Control in Underground Metal and Nonmetal Fires
- OSHA - 29 CFR 1926 Subpart S, Underground Construction, Caissons, Cofferdams, and Compressed Air
- NFPA 30, Flammable and Combustible Liquids Code
- Emergency evacuation plan and procedures
- General Safety Manuals and Training
- Operating and Maintenance Instructions

Note: Upon completion of the installation of the Emergency Refuge Stations, the drawings, training lesson plans, procedures, manufacturer's operations and maintenance manuals, etc. will be updated to reflect the design and operation of the Emergency Refuge Stations as well as other mitigation/control features.

10. FINAL Hazard Classification:

Frequency Rating:	E - Improbable
Consequence Rating:	I - Catastrophic
Initial Risk Rating:	Low

Scenario Analysis Summary		
1. Scenario Number: U16006	2. Revision: 0	3. Revision Date: December 2001
4. Location: ECRB Cross-Drift		

5. **Scenario Description:** Fire due to the ignition of trash, solvents, chemicals, or other combustible products Minor system/equipment damage results from this fire with the potential for minor injury to workers

6. **Cause, Failure, or Hazardous Event:**
   - Welding or cutting operations
   - Electrical cables
   - Electrical connections/splices
   - Outlets sparking in the presence of hydraulic fluid, lubricating oil, cleaning solvents, disposable cleaning materials, trash or other transient debris
   - Catalytic reactions involving the above materials
   - Human Error
   - Failure to adhere to safety procedures and rules

7. **INITIAL Hazard Classification:**

Frequency Rating	D - Remote
Consequence Rating	III - Marginal
Initial Risk Rating	Extremely Low

8. a. **Required Mitigation/Control Features:** (Implementation and Verification Required)
   - Emergency Refuge Stations in the ECRB Cross-Drift 1) Alcove 8 refuge station equipped with respirators/bottle air system, half-mask respirators, and self-contained self-rescuers, 2) Bulkhead 17+63 refuge station with large volume of drift air equipped with gas detection/monitoring equipment and half-mask respirators
   - Procedures/controls to limit the number of visitors/workers in the ECRB Cross-Drift according to the number of respirators/compressed air bottles in the Emergency Refuge Station at Alcove 8 (30 persons corresponding to 30 bottles, up to a maximum of 53 persons corresponding to 53 bottles)
   - Fire suppression system/equipment (e g portable multi-purpose dry chemical fire extinguishers)
   - Personal self-rescuers
   - Install ESF alarm/notification system improvements
   - Install exit and emergency lighting systems

   b. **Defense-in-Depth Mitigation/Control Features:** (Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)
   - Compressed air system as redundant air supply system to the ECRB Cross-Drift Emergency Refuge Station(s)
   - Fire emergency procedures
   - Procedures for handling or working with combustible materials
   - Weld, cut and burn procedures
   - "Good Housekeeping procedures
   - Establish regular inspection and maintenance procedures and schedule, maintain inspection and safety records
   - Safety training, including identification of fire hazards and corrective actions

9. Mitigation Documentation:

- Exploratory Studies Facility Subsurface Fire Hazards Analysis, BABFAH000-01717-0200-00121 Rev 02
- Calculation of ECRB Cross-Drift Worst-Case Fire and Effects, BAB000000-01717-0210-00001 Rev 00
- ECRB Refuge Chamber, BABEAF000-01717-0210-00011 REV00
- ECRB Refuge Station General Arrangement and Details BABEAF000-01717-2100-40361 REV 00 DCN01
- Determination, Decision, or Directive Documentation DF 02-0013
- ANSI/IEEE C2, National Electrical Safety Code
- NEMA and UL standards
- NFPA 122, Standard for Fire Prevention and Control in Underground Metal and Nonmetal Fires
- OSHA - 29 CFR 1926 Subpart S, Underground Construction, Caissons, Cofferdams, and Compressed Air
- NFPA 30, Flammable and Combustible Liquids Code
- Emergency evacuation plan and procedures
- General Safety Manuals and Training
- Operating and Maintenance Instructions

Note: Upon completion of the installation of the Emergency Refuge Stations, the drawings, training lesson plans, procedures, manufacturer's operations and maintenance manuals, etc. will be updated to reflect the design and operation of the Emergency Refuge Stations as well as other mitigation/control features.

10. FINAL Hazard Classification:

Frequency Rating	D - Remote
Consequence Rating	IV - Negligible
Initial Risk Rating	Extremely Low

APPENDIX B

PREVIOUSLY COMPLETED SCENARIO ANALYSIS SUMMARIES

Scenario Analysis Summary		
1. Scenario Number: UI5028	**2. Revision:** 00	**3. Revision Date:** 10/28/97
4. Location: East-West Drift		
5. Scenario Description: Fire involving subsurface vehicle (e g , Alpine Miner, front-end loader, drill jumbo) or temporarily stored materials		

6. Cause, Failure, or Hazardous Event:

- Unsafe vehicles (e g , improper maintenance)
- Fuel source (diesel fuel) exposed to ignition source (e g , spark, flame)
- Use of unauthorized vehicle underground
- Poor housekeeping
- Lack of storage space/facilities
- Failure to adhere to safety procedures

7. INITIAL Hazard Classification:

Frequency Rating	Not Available/Not Completed
Consequence Rating	Not Available/Not Completed
Initial Risk Rating	Not Available/Not Completed

8. a. Required Mitigation/Control Features: (Implementation and Verification Required)

- Implementing Procedures for handling/working around combustible materials (e g , disposal, proper storage, no smoking)
- Use fire-resistant materials whenever practical
- Provide approved storage containers
- Limit diesel fuel storage volume to no more than 24-hour supply
- Provide safety training (e g , rules and regulations concerning employee safety and the safety of others, parking of vehicles
- Install portable extinguisher and hose station in the Starter Tunnel
- Install onboard fire suppression systems (hose stations and portable fire extinguishers on locomotives and front-end loaders
- Establish vehicle inspection and maintenance schedule
- Evacuate in accordance with Emergency Plan
- Ventilation system
- Use of self-rescuer as required

b. Defense-in-Depth Mitigation/Control Features: Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)

Not Available/Not Completed

9. Mitigation Documentation:

- OSHA - 29 CFR 1926 800, NFPA Fire Protection Rules and Regulations
- Maintenance manuals and safety manual
- Inspection and maintenance records

10. FINAL Hazard Classification:

Frequency Rating: E - Improbable
Consequence Rating: III - Marginal
Initial Risk Rating: Extremely Low

Scenario Analysis Summary		
1. Scenario Number: U15030	**2. Revision:** 00	**3. Revision Date:** 10/28/97
4. Location: East-West Drift		
5. Scenario Description: Fire due to failure/short/overload of electrical switchgear or other electrical equipment (e g , transformer, electrical panel box, electrical wire or cable)		

6. Cause, Failure, or Hazardous Event:

- Bad winding insulation
- Short circuit inside electrical panel box
- Insulation failure (e g , cable breach, electrical overload)

7. INITIAL Hazard Classification:

Frequency Rating	Not Available/Not Completed
Consequence Rating	Not Available/Not Completed
Initial Risk Rating	Not Available/Not Completed

8. a. Required Mitigation/Control Features: (Implementation and Verification Required)

- Design electrical systems/components to applicable codes and standards
- Conduct inspections during installation and connection
- Incorporate protective devices (e g , fuses, circuit breakers, temperature relays) where appropriate
- Field test according to applicable specifications
- Provide portable extinguisher and hose station in Starter Tunnel
- Establish inspection and maintenance schedule
- Provide safety training
- Ensure cable meets applicable codes and standards

b. Defense-in-Depth Mitigation/Control Features: Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)

Not Available/Not Completed

9. Mitigation Documentation:

- ANSI/IEEE C2-93, OSHA 29 CFR 1926
- National Safety Code
- National Electrical Code
- NEMA and UL standards
- System specifications,
- Maintenance manuals
- Safety manuals
- Inspection and maintenance records

10. FINAL Hazard Classification:

Frequency Rating	D - Remote
Consequence Rating	III - Marginal
Initial Risk Rating	Extremely Low

Scenario Analysis Summary		
1. Scenario Number: UI5057	**2. Revision:** 0	**3. Revision Date:** 10/28/97

4. Location: East-West Drift

5. Scenario Description: General underground fire due to ignition of trash, solvents, chemicals, or other combustible products

6. Cause, Failure, or Hazardous Event:

- Electrical cables
- Connections (splices)
- Outlets sparking in the presence of hydraulic fluid, lubrication oil, diesel fuel, cleaning solvents, disposable cleanup materials, or catalytic reactions involving the above materials
- Lack of storage space/facilities

7. INITIAL Hazard Classification:

Frequency Rating	Not Available/Not Completed
Consequence Rating	Not Available/Not Completed
Initial Risk Rating	Not Available/Not Completed

8. a. Required Mitigation/Control Features: (Implementation and Verification Required)

- Implement JSAs/procedures for handling or working with combustible materials
- Minimize use of combustible materials underground
- "Weld, cut and burn" procedures in effect for all underground areas
- Use fire-resistant materials whenever practical
- Provide approved storage containers
- Provide safety training (e g , identification of fire hazards, corrective actions)
- Install portable extinguisher and hose stations in the Starter Tunnel
- Limit diesel fuel storage volume to no more than 24-hour supply
- Implement good "house keeping" in the subsurface
- Use self-rescuer as required
- Ventilation system
- Implement emergency evacuation plan

b. Defense-in-Depth Mitigation/Control Features: Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)

Not Available/Not Completed

9. Mitigation Documentation:

- Safety Manuals
- OSHA - 29 CFR 1926 Subpart S
- NFPA Fire Protection Rules and Regulations

10. FINAL Hazard Classification:

Frequency Rating	D - Remote
Consequence Rating	III - Marginal
Initial Risk Rating	Extremely Low

Scenario Analysis Summary

1. Scenario Number: UI5080	2. Revision: 0	3. Revision Date: 10/28/97

4. Location: East-West Drift

5. Scenario Description: Fire hazards Conveyor system

6. Cause, Failure, or Hazardous Event:

- Conveyor belt fire due to friction on bearings
- Idlers frozen

7. INITIAL Hazard Classification:

Frequency Rating	Not Available/Not Completed
Consequence Rating	Not Available/Not Completed
Initial Risk Rating	Not Available/Not Completed

8. a. Required Mitigation/Control Features: (Implementation and Verification Required)

- Install automatic fire suppression systems at all transfer points
- Install fire resistant belts
- Provide wall-mounted fire extinguishers at each electric panel site and every 500-600 feet on the tunnel wall
- Establish inspection, maintenance procedures and schedule for conveyor components, maintain inspection and maintenance records

b. Defense-in-Depth Mitigation/Control Features: (Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)

Not Available/Not Completed

9. Mitigation Documentation:

- OSHA - 29 CFR 1926 Subparts S & F
- NFPA Fire Protection Rules and Regulations
- System specifications
- Maintenance and safety manuals

10. FINAL Hazard Classification:

Frequency Rating	E - Improbable
Consequence Rating	II - Critical
Initial Risk Rating	Low

Scenario Analysis Summary

1. Scenario Number: UI5086	2. Revision: 0	3. Revision Date: 10/28/97

4. Location: East-West Drift

5. Scenario Description: Vehicle diesel fire hazard diesel leak(s) from fuel tank or fuel lines during refueling activities (dropping container, inattention to refueling process)

6. Cause, Failure, or Hazardous Event:

- Mechanical failure(s) of container, fuel lines/joints
- Human error during refueling activities (dropping container, inattention to refueling process)

7. INITIAL Hazard Classification:

Frequency Rating	Not Available/Not Completed
Consequence Rating	Not Available/Not Completed
Initial Risk Rating	Not Available/Not Completed

8. a. Required Mitigation/Control Features: (Implementation and Verification Required)

- Install automatic fire suppression on the refueling vehicle
- Daily inspection of diesel engine compartment and fuel lines to detect any small leaks
- All diesel refueling activities shall be a two-man operation One refuels and the other mans the fire extinguisher and diesel fuel cutoff valve
- Provide an automatic and/or manual fire suppression system in vehicle engine compartment
- Operator training on proper methods of handling diesel fuel and refueling procedures

b. Defense-in-Depth Mitigation/Control Features: Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)

Not Available/Not Completed

9. Mitigation Documentation:

- NFPA 124, Diesel Fuel and Diesel Equipment in Underground Mines
- NFPA 122, Standard for Storage of Flammable and Combustible Liquids within Underground Metal and Non-Metal Mines
- OSHA - 29 CFR 1926 Subpart S
- Subsurface Fire Hazards Analysis, BABFAH000-01717-0200-00121 Rev 0
- Subsurface Fire Protection Design Analysis, babfah000-01717-0200-00114 Rev 0
- Subsurface Fire Protection, BABFAH000-01717-6300-16721 Rev 0
- Fire Alarm and Smoke Detector System, BABFAH000-01717-6300-16721 Rev 0
- National Fire Protection Association NFPA 30-93
- Uniform Fire Code UFC-91
- Emergency evacuation plan and procedures
- Maintenance, operations and housekeeping procedures
- Inspection and maintenance records

10. FINAL Hazard Classification:

Frequency Rating	E - Improbable
Consequence Rating	II - Critical
Initial Risk Rating	Low

Scenario Analysis Summary		
1. Scenario Number: UI0354	2. Revision: 01	3. Revision Date: 7/8/96
4. Location: Main Drift		
5. Scenario Description: Personnel injury/equipment damage caused by a diesel fuel fire due to diesel fuel leak within engine compartment		
6. Cause, Failure, or Hazardous Event: • Diesel fuel spill or leak on hot surfaces (e g , engine exhaust manifold, turbocharger, brakes, worn bearings) • Diesel fuel line leak caused by age/rust or wear • Diesel fuel leak due to failure of mechanical joint • Human error (e g puncturing diesel fuel line) • Diesel fuel leak during refueling of diesel equipment		
7. INITIAL Hazard Classification: Frequency Rating: Not Available/Not Completed Consequence Rating: Not Available/Not Completed Initial Risk Rating: Not Available/Not Completed		
8. a. Required Mitigation/Control Features: (Implementation and Verification Required) • Control electrical sparking (use appropriate codes and regulations) • Control cigarette smoking around diesel equipment and diesel fuel • Control welding/cutting operation around diesel fuel tanks/containers • Provide at least one portable (ABC) dry chemical fire extinguisher on all mobile diesel equipment • Employee training on the location of and proper use of fire extinguisher and alternate fire suppression methods for fighting diesel fires in its incipient stage • Provide an automatic and/or manual fire suppression system for all mobile diesel equipment • Diesel fuel tanks for mobile diesel equipment shall be made of metal at least 1/16 " thick welded at all seams and mounted in a position to preclude damage during use • No separate or auxiliary fuel tank shall be attached on mobile diesel equipment • Install a fire detection system, portable fire extinguisher, and water hose stations along the main drift • Operator training on the proper methods of handling diesel fuel and refueling of diesel equipment • Establish inspection and maintenance procedures and schedule Maintain inspection and maintenance records • Emergency evacuation plan and procedures • Refuge chambers • Employee safety training on fire hazards, proper personal protective equipment and the proper use of self rescuers b. Defense-in-Depth Mitigation/Control Features: Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA) Not Available/Not Completed		

9. Mitigation Documentation:

- NFPA 124, Diesel Fuel and Diesel Equipment in Underground Mines
- FPA 122, Standard for Storage of Flammable and Combustible Liquids Within Underground Metal and Non-Metal Mines
- OSHA - 29 CFR 1926 Subpart S
- Subsurface Fire Hazard Analysis, BABFAH000-01717-0200-00121 Rev 0
- Subsurface Fire Protection Design Analysis, BABFAH000-01717-0200-00114 Rev 0
- Subsurface Fire Protection, BABFAH000-01717-6300-15300 Rev 0
- Fire Alarm And Smoke Detector System, BABBEB000-01717-6300-16721 Rev 0
- Emergency evacuation plan and procedures *
- Maintenance, operations and housekeeping procedures Inspection and maintenance records*

*It is the constructor's and operator's responsibility to assure that the hazard(s) associated with this scenario have been mitigated through proper documentation

10. FINAL Hazard Classification:

Frequency Rating	D - Remote
Consequence Rating	III - Marginal
Risk Designation	Extremely Low

Scenario Analysis Summary		
1. Scenario Number: UI0355	**2. Revision:** 01	**3. Revision Date:** 7/8/96
4. Location: Main Drift		

5. Scenario Description: Personnel injury/equipment damage caused by a diesel fuel fire due to electrical ignition sources in the presence of diesel fuel, hydraulic fluid, lubricating oil, flammable cleaning solvents, disposable clean up materials

6. Cause, Failure, or Hazardous Event:

- Short circuit, wire insulation failure
- Transformer or electrical panel failure or overload
- Battery or generator electrical discharge
- Lighting fixture failure or damage

7. INITIAL Hazard Classification:

Frequency Rating	Not Available/Not Completed
Consequence Rating	Not Available/Not Completed
Initial Risk Rating	Not Available/Not Completed

8. a. Required Mitigation/Control Features: (Implementation and Verification Required)

- Control electrical sparking (use appropriate codes and regulations and inspection procedures using sealed motors or TEFC motors where appropriate)
- Incorporate protective devices (e g fuses, circuit breakers, temperature relays)
- Control fuel sources (hydraulic fluid, lubricating oil, diesel fuel, flammable cleaning solvents, disposable clean up materials)
- Install a fire detection system, portable fire extinguisher, and water hose stations along the main drift
- Employee training on the location of and proper use of fire extinguisher and alternate fire suppression methods for fighting diesel fires in its incipient stage
- Provide at least one portable (ABC) dry chemical fire extinguisher on all mobile diesel equipment
- Provide an automatic and/or manual fire suppression system for all mobile diesel equipment
- Diesel fuel tanks for mobile diesel equipment shall be made of metal at least 1/16 " thick welded at all seams and mounted in a position to preclude damage during use
- No separate or auxiliary fuel tank shall be attached on mobile diesel equipment
- Establish inspection and maintenance procedures and schedule, maintain inspection and maintenance records
- Establish good housekeeping practice to control combustible materials
- Emergency evacuation plan and procedures
- Refuge chambers
- Employee safety training on fire hazards, proper personal protective equipment and the proper use of self rescuers

b. Defense-in-Depth Mitigation/Control Features: Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)

Not Available/Not Completed

9. Mitigation Documentation:

- NFPA 124, Diesel Fuel and Diesel Equipment in Underground Mines
- NFPA 122, Standard for Storage of Flammable and Combustible Liquids Within Underground Metal and Non-Metal Mines
- OSHA - 29 CFR 1926 Subpart S
- Subsurface Fire Hazard Analysis, BABFAH000-01717-0200-00121 Rev. 0
- Subsurface Fire Protection Design Analysis, BABFAH000-01717-0200-00114 Rev. 0
- Subsurface Fire Protection, BABFAH000-01717-6300-15300 Rev. 0
- Fire Alarm And Smoke Detector System, BABBEB000-01717-6300-16721 Rev. 0
- Emergency evacuation plan and procedures*
- Maintenance, operations and housekeeping procedures. Inspection and maintenance records*

*It is the constructor's and operator's responsibility to assure that the hazard(s) associated with this scenario have been mitigated through proper documentation.

10. <u>FINAL</u> Hazard Classification:

Frequency Rating:	E - Improbable
Consequence Rating:	II - Critical
Risk Designation:	Low

Scenario Analysis Summary		
1. Scenario Number: UI0356	**2. Revision:** 01	**3. Revision Date:** 7/8/96
4. Location: Main Drift		

5. Scenario Description: Personnel injury/equipment damage caused by a diesel fuel fire due to mechanical ignition sources in the presence of diesel fuel, hydraulic fluid, lubricating oil, flammable cleaning solvents, disposable clean up materials

6. Cause, Failure, or Hazardous Event:

- Mechanical (friction) sparking due to lockup or impact
- Overheating of bearings, brakes, motors

7. INITIAL Hazard Classification:

Frequency Rating	Not Available/Not Completed
Consequence Rating	Not Available/Not Completed
Initial Risk Rating	Not Available/Not Completed

8. a. Required Mitigation/Control Features: (Implementation and Verification Required)

- Control fuel sources (hydraulic fluid, lubricating oil, diesel fuel, flammable cleaning solvents, disposable clean up materials)
- Install a fire detection system, portable fire extinguisher, and water hose stations along the main drift
- Employee training on the location of and proper use of fire extinguisher and alternate fire suppression methods for fighting diesel fires in its incipient stage
- Provide at least one portable (ABC) dry chemical fire extinguisher on all mobile diesel equipment
- Provide an automatic and/or manual fire suppression system for all mobile diesel equipment
- Diesel fuel tanks for mobile diesel equipment shall be made of metal at least 1/16 " thick welded at all seams and mounted in a position to preclude damage during use
- No separate or auxiliary fuel tank shall be attached on mobile diesel equipment
- Establish inspection and maintenance procedures and schedule, maintain inspection and maintenance records
- Establish good housekeeping practice to control combustible materials
- Emergency evacuation plan and procedures
- Refuge chambers
- Employee safety training on fire hazards, proper personal protective equipment and the proper use of self rescuers

b. Defense-in-Depth Mitigation/Control Features: Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements, (i e , OSHA)

Not Available/Not Completed

9. Mitigation Documentation:

- NFPA 124, Diesel Fuel and Diesel Equipment in Underground Mines
- NFPA 122, Standard for Storage of Flammable and Combustible Liquids Within Underground Metal and Non-Metal Mines
- OSHA - 29 CFR 1926 Subpart S
- Subsurface Fire Protection, BABFAH000-01717-6300-15300 Rev. 0
- Fire Alarm And Smoke Detector System, BABBEB000-01717-6300-16721 Rev.0
- Surface and Subsurface Material Handling Flow Diagram, BABFC0000-01717-2100-45031, (Identifies locations of automatic dry chemical fire suppression systems for the surface and subsurface conveyor)
- Emergency evacuation plan and procedures.*
- Maintenance, operations and housekeeping procedures. Inspection and maintenance records*

*It is the constructor's and operator's responsibility to assure that the hazard(s) associated with this scenario have been mitigated through proper documentation.

10. FINAL Hazard Classification:

Frequency Rating:	E - Improbable
Consequence Rating:	II - Critical
Risk Designation:	Low

Scenario Analysis Summary		
1. Scenario Number: UI0357	**2. Revision:** 01	**3. Revision Date:** 7/8/96
4. Location: Main Drift		
5. Scenario Description: Personnel injury/equipment damage caused by a diesel fuel fire due to ignition by open flame or heating device in the presence of diesel fuel, hydraulic fluid, lubricating oil, flammable cleaning solvents, disposable clean-up materials		
6. Cause, Failure, or Hazardous Event: • Diesel fuel leak • Trash fire • Welding/cutting or open flame • Space heaters or test equipment heating elements		
7. INITIAL Hazard Classification: Frequency Rating: Not Available/Not Completed Consequence Rating: Not Available/Not Completed Initial Risk Rating: Not Available/Not Completed		
8. a. Required Mitigation/Control Features: (Implementation and Verification Required) • Control cigarette smoking around diesel equipment and diesel fuel • Control welding/cutting operations around diesel equipment, fuel tanks, and storage containers • Employee training on the location of and proper use of fire extinguisher and alternate fire suppression methods for fighting diesel fires in its incipient stage • Provide at least one portable (ABC) dry chemical fire extinguisher on all mobile diesel equipment • Provide an automatic and/or manual fire suppression system for all mobile diesel equipment • Diesel fuel tanks for mobile diesel equipment shall be made of metal at least 1/16 " thick welded at all seams and mounted in a position to preclude damage during use • No separate or auxiliary fuel tank shall be attached on mobile diesel equipment • Install a fire detection system, portable fire extinguisher, and water hose stations along the main drift • Establish inspection and maintenance procedures and schedule, maintain inspection and maintenance records • Refuge chambers • Emergency evacuation plan and procedures • Employee safety training on fire hazards, proper personal protective equipment and the proper use of self rescuers **b. Defense-In-Depth Mitigation/Control Features:** Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA) Not Available/Not Completed		

9. Mitigation Documentation:

- NFPA 124, Diesel Fuel and Diesel Equipment in Underground Mines
- NFPA 122, Standard for Storage of Flammable and Combustible Liquids Within Underground Metal and Non-Metal Mines
- OSHA - 29 CFR 1926 Subpart S
- Subsurface Fire Hazard Analysis, BABFAH000-01717-0200-00121 Rev. 0
- Subsurface Fire Protection Design Analysis, BABFAH000-01717-0200-00114 Rev. 0
- Subsurface Fire Protection, BABFAH000-01717-6300-15300 Rev. 0
- Fire Alarm And Smoke Detector System, BABBEB000-01717-6300-16721 Rev.0
- Emergency evacuation plan and procedures.*
- Maintenance, operations and housekeeping procedures. Inspection and maintenance records*

*It is the constructor's and operator's responsibility to assure that the hazard(s) associated with this scenario have been mitigated through proper documentation.

10. FINAL Hazard Classification:

Frequency Rating:	E - Improbable
Consequence Rating:	II - Critical
Risk Designation:	Low

Scenario Analysis Summary		
1. Scenario Number: UI0358	**2. Revision:** 01	**3. Revision Date:** 7/8/96
4. Location: Main Drift		

5. Scenario Description: Personnel injury/equipment damage caused by diesel fire on diesel locomotive while transporting diesel fuel into tunnel

6. Cause, Failure, or Hazardous Event:

- Electrical or mechanical sparks in the presence of hydraulic fluid, lubricating oil, diesel fuel, flammable cleaning solvents, disposable clean up materials
- Runaway vehicle, failure to adhere to safety procedures

7. INITIAL Hazard Classification:

Frequency Rating	Not Available/Not Completed
Consequence Rating	Not Available/Not Completed
Initial Risk Rating	Not Available/Not Completed

8. a. Required Mitigation/Control Features: (Implementation and Verification Required)

- Diesel fuel shall be stored in and transferred (into the tunnel) in approved containers
- Diesel fuel shall not be transferred into the tunnel in the same conveyance with personnel
- When diesel fuel is transferred into the tunnel, it shall be transferred directly to the storage area or location where it will be used
- Operator training on the proper methods of handling diesel fuel and refueling of diesel equipment
- Control cigarette smoking around diesel equipment and diesel fuel
- Employee training on the location of and proper use of fire extinguisher and alternate fire suppression methods for fighting diesel fires in its incipient stage
- Provide at least one portable (ABC) dry chemical fire extinguisher on all mobile diesel equipment
- Provide an automatic and/or manual fire suppression system for all mobile diesel equipment
- Install a fire detection system, portable fire extinguisher, and water hose stations along the main drift
- Establish inspection and maintenance procedures and schedule, maintain inspection and maintenance records
- Emergency evacuation plan and procedures
- Refuge chambers
- Employee safety training on fire hazards, proper personal protective equipment and the proper use of self rescuers

b. **Defense-in-Depth Mitigation/Control Features:** Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)

Not Available/Not Completed

9. Mitigation Documentation:

- NFPA 124, Diesel Fuel and Diesel Equipment in Underground Mines
- NFPA 122, Standard for Storage of Flammable and Combustible Liquids Within Underground Metal and Non-Metal Mines
- OSHA - 29 CFR 1926 Subpart S
- Subsurface Fire Hazard Analysis, BABFAH000-01717-0200-00121 Rev. 0
- Subsurface Fire Protection Design Analysis, BABFAH000-01717-0200-00114 Rev. 0
- Subsurface Fire Protection, BABFAH000-01717-6300-15300 Rev. 0
- Fire Alarm And Smoke Detector System, BABBEB000-01717-6300-16721 Rev.0
- Emergency evacuation plan and procedures.*
- Maintenance, operations and housekeeping procedures. Inspection and maintenance records*

*It is the constructor's and operator's responsibility to assure that the hazard(s) associated with this scenario have been mitigated through proper documentation.

10. FINAL Hazard Classification:

Frequency Rating:	E - Improbable
Consequence Rating:	II - Critical
Risk Designation:	Low

Scenario Analysis Summary		
1. Scenario Number: UI0359	**2. Revision:** 01	**3. Revision Date:** 7/8/96
4. Location: Main Drift		
5. Scenario Description: Personnel injury/equipment damage caused by fire in diesel fuel storage area		

6. Cause, Failure, or Hazardous Event:

- Electrical or mechanical sparks in the presence of hydraulic fluid, lubricating oil, diesel fuel, flammable cleaning solvents, disposable clean up materials
- Smoldering ashes from cigarettes in the presence of hydraulic fluid, lubricating oil, diesel fuel, flammable cleaning solvents, disposable clean up materials
- Diesel fuel leak
- Trash fire

7. INITIAL Hazard Classification:

Frequency Rating	Not Available/Not Completed
Consequence Rating	Not Available/Not Completed
Initial Risk Rating	Not Available/Not Completed

8. a. Required Mitigation/Control Features: (Implementation and Verification Required)

- Diesel fuel shall be stored in and transferred (into the tunnel) in approved containers
- Post safety/warning signs in diesel fuel storage areas
- Control storage of diesel fuel away from electrical components (e g transformers, electrical panels), out of travelway of vehicular traffic, and at least 50 feet from explosives, shafts and shops
- Control fuel sources (hydraulic fluid , lubricating oil (leak resistant seals in common use), diesel fuel, flammable cleaning solvents (prohibit use of solvents that by NFPA definitions can be classified as flammable), disposable clean up materials), if combustible gasses are projected to be above 10% of lower flammable limit at any time during operation use combustible gas sensors
- Control cigarette smoking around diesel equipment and diesel fuel
- Employee training on the location of and proper use of fire extinguisher and alternate fire suppression methods for fighting diesel fires in its incipient stage
- Install a fire detection system, portable fire extinguisher, and water hose stations along the main drift
- Operator training on the proper methods of handling diesel fuel and refueling of diesel equipment
- Establish inspection and maintenance procedures and schedule, maintain inspection and maintenance records
- Emergency evacuation plan and procedures
- Refuge chambers
- Employee safety training on fire hazards, proper personal protective equipment and the proper use of self rescuers

b. Defense-In-Depth Mitigation/Control Features: Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)

Not Available/Not Completed

9. Mitigation Documentation:

- NFPA 124, Diesel Fuel and Diesel Equipment in Underground Mines
- NFPA 122, Standard for Storage of Flammable and Combustible Liquids Within Underground Metal and Non-Metal Mines
- OSHA - 29 CFR 1926 Subpart S
- Subsurface Fire Hazard Analysis, BABFAH000-01717-0200-00121 Rev. 0
- Subsurface Fire Protection Design Analysis, BABFAH000-01717-0200-00114 Rev. 0
- Subsurface Fire Protection, BABFAH000-01717-6300-15300 Rev. 0
- Fire Alarm And Smoke Detector System, BABBEB000-01717-6300-16721 Rev.0
- Emergency evacuation plan and procedures.*
- Maintenance, operations and housekeeping procedures. Inspection and maintenance records*

*It is the constructor's and operator's responsibility to assure that the hazard(s) associated with this scenario have been mitigated through proper documentation.

10. FINAL Hazard Classification:

Frequency Rating:	E - Improbable
Consequence Rating:	II - Critical
Risk Designation:	Low

Scenario Analysis Summary		
1. Scenario Number: UI0361	**2. Revision:** 01	**3. Revision Date:** 7/8/96
4. Location: Main Drift		

5. Scenario Description: Personnel injury/equipment damage caused by a diesel fuel fire due to diesel fuel leak from fuel tank

6. Cause, Failure, or Hazardous Event:

- Diesel fuel spill or leak on hot surfaces (e g , engine exhaust, brakes, worn bearings)
- Diesel fuel tank leak caused by age/rust or wear
- Diesel fuel leak due to failure of mechanical joint
- Human error (e g puncturing diesel fuel tank)
- Diesel fuel leak during refueling of diesel equipment

7. INITIAL Hazard Classification:

Frequency Rating	Not Available/Not Completed
Consequence Rating	Not Available/Not Completed
Initial Risk Rating	Not Available/Not Completed

8. a. Required Mitigation/Control Features: (Implementation and Verification Required)

- Control electrical sparking (use appropriate codes and regulations)
- Control cigarette smoking around diesel equipment and diesel fuel
- Control welding/cutting operation around diesel fuel tanks/containers
- Provide at least one portable (ABC) dry chemical fire extinguisher on all mobile diesel equipment
- Employee training on the location of and proper use of fire extinguisher and alternate fire suppression methods for fighting diesel fires in its incipient stage
- Provide an automatic and/or manual fire suppression system for all mobile diesel equipment
- Diesel fuel tanks for mobile diesel equipment shall be made of metal at least 1/16 " thick welded at all seams and mounted in a position to preclude damage during use
- No separate or auxiliary fuel tank shall be attached on mobile diesel equipment
- Install a fire detection system, portable fire extinguisher, and water hose stations along the main drift
- Operator training on the proper methods of handling diesel fuel and refueling of diesel equipment
- Establish inspection and maintenance procedures and schedule, maintain inspection and maintenance records
- Emergency evacuation plan and procedures
- Refuge chambers
- Employee safety training on fire hazards, proper personal protective equipment and the proper use of self rescuers

b. Defense-In-Depth Mitigation/Control Features: Implementation not required by the SSA to reach the Final Risk Rating NOTE May be required to satisfy other regulatory requirements (i e , OSHA)

Not Available/Not Completed

9. Mitigation Documentation:

- NFPA 124, Diesel Fuel and Diesel Equipment in Underground Mines
- NFPA 122, Standard for Storage of Flammable and Combustible Liquids Within Underground Metal and Non-Metal Mines
- OSHA - 29 CFR 1926 Subpart S
- Subsurface Fire Hazard Analysis, BABFAH000-01717-0200-00121 Rev 0
- Subsurface Fire Protection Design Analysis, BABFAH000-01717-0200-00114 Rev 0
- Subsurface Fire Protection, BABFAH000-01717-6300-15300 Rev 0
- Fire Alarm And Smoke Detector System, BABBEB000-01717-6300-16721 Rev 0
- Emergency evacuation plan and procedures *
- Maintenance, operations and housekeeping procedures Inspection and maintenance records*

*It is the constructor's and operator's responsibility to assure that the hazard(s) associated with this scenario have been mitigated through proper documentation

10. FINAL Hazard Classification:

Frequency Rating	E - Improbable
Consequence Rating	II - Critical
Risk Designation	Low